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ROUTING METHOD FOR A COMMUNICATION NETWORK

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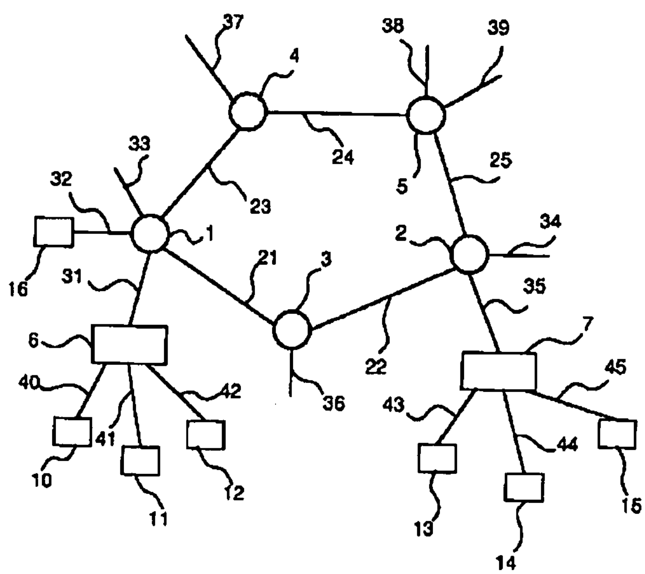
Abstract

Object: To provide subscribers with a low-cost communication service, and to smooth the input traffic of a communication network.

Constitution: Nodes 1, 2, 3, 4 and 5 periodically monitor the utilization of output lines 21, 22, 23, 24 and 25, update a communication charge [1]* in accordance with the utilization, and store [*the updated charge*] [2] in the nodes. Node 2 periodically sends a communication charge notification cell to an active communication channel [3] consisting of communication line 22 [4], node 3, line 21 and node 1, and to a standby channel consisting of line 25, node 5, line 24, node 4, line 23 and node 1. When nodes 1, 3, 4 and 5 receive the charge notification cell, they write therein the communication charge at the time of reception, and send [*the charge notification cell*] to the next node or to subscriber communication equipment. [5] When subscriber equipment 6 receives charge notification cells, it selects whichever of the active and standby channels is cheaper, and [*if necessary*] switches communication [*accordingly*].



1-5: nodes; 10-16: terminals; 21-25: internode lines; 31-39: subscriber lines; 40-45: in-home lines

* Numbers in square brackets refer to Translator's Notes appended to the translation.

Claims

1. A routing method for a communication network, comprising, in a network [6] in which a plurality of communication terminals [7] are linked by communication lines via one or more communication nodes [8]:

periodically measuring input traffic at at least some of the nodes;

sending information relating to the measured traffic to a terminal or to a node directly connected to a terminal; and

at a source terminal [9] or at a node directly connected to a source terminal, controlling routing between said source terminal and a destination terminal [10] on the basis of said traffic-related information.

2. The routing method for a communication network according to claim 1, wherein the network linked by communication lines via a plurality of nodes is an ATM switched network [11]; and the measured traffic-related information is sent by means of an ATM cell comprising a header containing a VPI and a VCI, and a payload containing the traffic-related information.

3. The routing method for a communication network according to claim 1 or 2, wherein the measured traffic-related information is information relating to a communication charge having a positive correlation with the amount of input traffic.

4. The routing method for a communication network according to claim 3, wherein the measured traffic-related information also contains routing information.

5. The routing method for a communication network according to claim 1, 2, 3 or 4, wherein routing between the source and destination terminals involves changing the route of, terminating, interrupting and restarting an active connection. [12]

6. The routing method for a communication network according to claim 1, 2, 3 or 4, wherein routing between the source and destination terminals is a matter of starting a new communication.

7. The routing method for a communication network according to claim 5, wherein a terminal registers, in a node, connections that can be started, terminated, interrupted and restarted; and said node performs control to minimise the communication charge levied on a source terminal.

8. An ATM switching node comprising:

a plurality of interface circuits [*for interfacing*] with communication lines;

a call processing and network management processor; and

an ATM switch for switching cells from said interface circuits and from said call processing and network management processor;

wherein [*each of*] said interface circuits comprises:

measuring means for periodically measuring input traffic;

means for obtaining charge information corresponding to the input traffic measured by said measuring means; and

means for storing said charge information in an information field of a charge notification cell when a network management cell input to the interface circuit is a charge notification cell, and forwarding [*this cell*].

9. An ATM switching node comprising:

a plurality of interface circuits [*for interfacing*] with communication lines;

a call processing and network management processor; and

an ATM switch for switching cells from said interface circuits and from said call processing and network management processor;

wherein:

(i) [*each of*] said interface circuits comprises measuring means for periodically measuring input traffic; and

(ii) said call processing and network management processor comprises:

means for obtaining charge information corresponding to the input traffic measured by said measuring means; and

means for storing said charge information in an information field of a charge notification cell when a network management cell input to an interface circuit is a charge notification cell, and forwarding [*this cell*].

Detailed Description of the Invention

Field of industrial applicability

[0001] The present invention relates to routing methods for communication networks, and in particular to methods for controlling communication routes in accordance with the amount of traffic input to the network.

Prior art

[0002] Traffic in networks such as telephone switched networks exhibits a daily peak during a specific daytime period, while during the night there is hardly any traffic. There are also peaks in traffic on particular days during each month and year. In addition, congestion may occur as a result of excessive traffic input due to an event such as telephone booking of tickets. It is not economical to provide communication facilities with spare traffic capacity so as to avoid deterioration of communication quality (call loss probability, etc.) when peak traffic occurs, and therefore the communication facilities conventionally provided have less capacity than that required for peak traffic. Accordingly, when traffic in excess of the capacity of the facilities is input, the proposed approach – as taught for example in Japanese Published Patent Application, Pub. No. 61-251261 – is to utilize the fact that [*traffic*] peaks on different communication lines do not coincide, and to establish routes so that traffic is distributed to many lines, thereby controlling traffic so as to prevent deterioration in communication quality.

[0003] Now, communication charges in a network comprise a monthly fixed portion and a variable portion determined by communication time or by communication time and amount of information communicated. As regards this variable portion, the communication charge per unit time or per unit amount of information communicated is changed in the course of a day in accordance with demand – [*as estimated*] from the result of monitoring the amount of traffic over a long period of time – and is higher during the day and cheaper at night. Nevertheless, the unit charge is conventionally fixed within a given time period. In this case, the charge levied on subscribers is determined independently of actual input traffic in the network, and therefore the same charge has conventionally been applied within a given time period whether the network has hardly any traffic or is overloaded.

Problems to be solved by the invention

[0004] The following problem may arise in the above-mentioned conventional method of distributing traffic to many communication lines. Namely, if peak traffic is input to a certain line and at the same time peak traffic is also input to a bypass line, it becomes difficult to reroute traffic and so communication quality ends up deteriorating. Moreover, the conventional approach of setting communication charges by fixing them within a given time period is not satisfactory with regard to (i) decreasing communication charge when input traffic is low and (ii) increasing total revenue by increasing traffic and improving the utilization efficiency of communication facilities. It is therefore an object of the present

invention to provide a routing method for a communication network which distributes traffic effectively in accordance with the actual amount of traffic and which smoothes the amount of traffic.

Means for solving problems

[0005] To attain the aforementioned object, the routing method for a communication network of the present invention comprises (i) measuring the amount of traffic input at each node device (hereinafter, termed simply "node") comprising a network between source and destination terminals, (ii) communicating, to the nodes and source terminals, information relating to the amount of traffic input to a communication line (as measured at the nodes), and (iii) controlling the start, termination, interruption or restart of transmission at a source terminal or a node that has received this information. The information relating to the amount of traffic input to a communication line is preferably information relating to a communication charge having a positive correlation with the amount of traffic input to the network.

Working of the invention

[0006] A source terminal or a node that has received information relating to the amount of input traffic controls session start, termination, interruption and restart so that the amount of traffic decreases. If the information relating to the amount of input traffic is information relating to a communication charge that has a positive correlation with the amount of traffic input to the network, then a source terminal or a node that has received this information controls – on the basis of the notified communication charge – session start, termination, interruption and restart so that cost is minimised. The source terminal or node can therefore smooth traffic by shifting traffic to a line with a lower communication charge – i.e., by shifting traffic to a line having less traffic. In particular, if congestion has spread to many nodes in a network, by changing the criteria for setting communication charges, subscribers can be urged to terminate or interrupt sessions in order to reduce cost, and as a result the traffic that is input to overloaded lines can be decreased.

[0007] In addition, even if a malicious subscriber or a malfunctioning subscriber terminal were to attempt to add traffic to an overloaded line, the network in question would reject a channel setup request and hence no further overloading would occur. A subscriber having a source terminal that has received a [*communication charge*] notification can decrease communication cost by controlling communication on the basis of the notified communication charge.

Embodiments

[0008] FIG. 1 shows an embodiment of a communication network in which the routing method of the present invention is implemented. This exemplary network is an asynchronous transfer mode (ATM) switched network, and information is exchanged between nodes by means of cells having a fixed word number. The information relating to the amount of input traffic is information relating to communication charge having a positive correlation with the amount of traffic input to the network. The referencing numerals appearing in FIG. 1 denote the following: 1 to 5... nodes; 6, 7... subscriber equipment; 10 to 16... terminals; 21 to 25... internode lines; 31 to 39... subscriber lines; 40 to 45... in-home lines.

[0009] In FIG. 1, if a communication channel (a virtual path connection or a virtual channel connection) from source terminal 10 to destination terminal 13 is set up on node 1, line 21, node 3, line 22 and node 2, then a standby channel is set up on node 1, line 23, node 4, line 24, node 5, line 25 and node 2. Depending on the configuration of the network, a plurality of such standby channels can be set up. The foregoing configuration and operation is identical to that of hitherto known ATM networks.

[0010] In this embodiment, in order to apply the routing method, nodes 1 to 5 periodically measure the utilization – i.e., the traffic – of internode lines 21 to 25; obtain communication charges corresponding to this traffic; and store these in the nodes. FIG. 2 gives an example of how charges are set in correspondence with traffic, with the horizontal axis showing a count value (traffic) and the vertical axis showing communication charge. When the count rises, up to A1 the charge is C0, but when A1 is exceeded, the communication charge changes to C1. As the count continues to rise, the charge stays at C1 until the count reaches A3, but changes to C2 if A3 is exceeded. If the count drops after having exceeded A1, the communication charge stays at C1 until the count reaches A0, and changes to C0 when the count drops below A0. Likewise, if the count drops after having exceeded A3, the charge stays at C2 until the count reaches A2, and becomes C1 when the count value drops below A2. In this embodiment, although the count thresholds (A0 and A1, A2 and A3) differ according to whether the value is rising or falling, it would also be feasible to make A1 equal to A0, and A3 equal to A2.

[0011] When setting up a communication channel from source terminal 10 to destination terminal 13, node 2 periodically sends a charge notification cell to the active channel comprising line 22, node 3, line 21 and node 1, and to the standby channel comprising line 25,

node 5, line 24, node 4, line 23 and node 1. When nodes 1, 3, 4 and 5 receive the charge notification cell, they write the charge at the time of reception in this cell and send it to the next node or to subscriber equipment 6. Subscriber equipment 6 selects whichever of the active and standby channels is the more economical, and switches to this route.

[0012] FIG. 3 is a block diagram showing the configuration of an embodiment of node 2 in FIG. 1. The referencing numerals appearing in FIG. 3 denote the following: 51... ATM switch for switching cells; 52a, 52b, 52c and 52d... line interfaces for interfacing with lines 22, 25, 34 and 35 respectively; 53... processor for call processing and network management.

[0013] FIG. 4 is a block diagram showing the configuration of an embodiment of processor 53 in FIG. 3. The referencing numerals appearing in FIG. 4 denote the following: 61... packetizer, 62... processor, 63... cell generator, 64... service management list. Packetizer 61 restores cells that have been received from the switch (51 in FIG. 3) to packet format and sends [*the resulting packets*] to processor 62. Processor 62 processes the received call processing and network management packets, generates reply network management packets when a reply is required, and sends these to cell generator 63. Cell generator 63 converts the packets to cell format and sends [*the resulting cells*] to switch 51 shown in FIG. 3.

[0014] FIG. 5 shows the contents of an embodiment of service management list 64 in FIG. 4. (VPI1, VCI1), (VPI2, VCI2), ... (VPIm, VCIm) are the values of the virtual path identifiers and virtual channel identifiers of those virtual channel connections for which node 2 is the destination node and which utilise this service. VPIm+1, VPIm+2, ... VPIm+k are the values of the virtual path identifiers of those virtual path connections for which node 2 is the destination node and which utilise this service. VCI0 is the value of the virtual connection identifier [13] assigned to network management cells of the virtual path connections. Processor 62 periodically [14] sends a communication charge notification cell to the channels registered in service management list 64.

[0015] FIG. 6 shows the format of a network management cell used for network management. The cell comprises a 5-byte header and a 48-byte payload area. VPI is the virtual path identifier, VCI the virtual channel identifier, and PTI the payload type identifier (identifies whether the cell is a message cell or a network management cell). CLP indicates cell loss priority and HEC is a header error correction code. OAM Type is a cell type identifier for network management. If the cell is a communication charge notification cell, the remaining payload area is used as follows. Link Stage indicates the number of traversed node stages.

Info 1, Info 2, ... Info ***n*** are fields for storing communication charge information for the input lines of the 1st, 2nd, ... nth nodes (counting from the destination node on the channel in question). "Unused" is an unused field. CRC-10 is a field in which a 10-bit error correction code is stored.

[0016] Assuming that the network management cell identifier field OAM Type is 1 byte in size, the traversed node stage number field Link Stage is 1 byte, and each charge information field Info ***i*** is 1 byte, then one cell is capable of storing communication charge information for 44 nodes. However, the size of the storage fields [15] could be different from 1 byte.

[0017] Processor 62 sets the VPI and VCI values in the header of a charge notification cell to the same values as the VPI and VCI of a virtual path connection and a virtual channel connection registered in the service management list. [16] It sets the value of PTI to the value assigned to a network management cell. It sets the network management cell type identifier OAM Type in the payload to the value assigned to a charge notification cell, and initialises the link stage number Link Stage to zero. It sets all other payload fields to zero. Finally, it computes the 10-bit error correction code for the payload and sets this in the 10-bit error correction code field CRC-10.

[0018] FIG. 7 is a block diagram showing the configuration of an embodiment of line interface 52a in FIG. 3. The referencing numerals appearing in FIG. 7 denote the following: 71 and 74... cell header PTI checkers; 72... header converter; 73... processor; 75... cell combiner; 76... timer; 77... counter; 78... charge table; 79... charge register. Counter 77 counts up by one each time a cell is output from cell combiner 75. Timer 76 periodically [17] sends a signal to counter 77, and when this signal is sent counter 77 notifies processor 73 of the count at that point in time, and resets the count to zero. When processor 73 receives notification of the count, it reads the charge information corresponding to that count from charge table 78, and stores [*the charge information*] in charge register 79.

[0019] When a cell is input to line interface 52a, PTI checker 71 checks the header PTI value. If the cell is a network management cell, it is sent to processor 73, otherwise it is sent to header converter 72. A network management cell that has been sent to processor 73 has its network management cell type identifier OAM Type checked. If the network management cell in question is a communication charge notification cell, processor 73 reads charge information from charge register 79, stores it in storage field Info ***i*** designated by the value ***i*** of Link Stage (the traversed node stage number), and sends [*the cell*] to header converter 72.

If the network management cell in question is other than a charge notification cell, it is processed by processor 73. If a reply is required, [*processor 73*] generates a reply network management cell, which is sent to either header converter 72 or cell combiner 75.

[0020] For each channel, header converter 72 stores – in the cell header VPI and VCI storage fields – the VPI and VCI values that have been assigned on the output lines of the node in question, and also stores routing information pertaining to switch 51 in a routing information storage region. Further, header converter 72 (i) reads cells that have been sent from PTI checker 71 and cells that have been sent from processor 73 in an order based on a predetermined priority, (ii) rewrites the header VPI and VCI values of the cells that have been read to the values assigned on the output lines of the node in question, (iii) adds the routing information pertaining to switch 51 as an additional header, and (iv) sends [*the cells*] to switch 51. PTI checker 74 deletes the additional header from a cell that has been sent from switch 51, checks the header PTI value, and in the case of a network management cell sends it to processor 73, and otherwise sends the cell to cell combiner 75. A network management cell that has been sent to processor 73 undergoes the same processing as a network management cell sent from PTI checker 71. Cell combiner 75 outputs cells sent from PTI checker 74 and cells sent from processor 73 to communication link 22 on the basis of a predetermined priority.

[0021] FIG. 8 is a block diagram showing the configuration of an embodiment of subscriber equipment 6 in FIG. 1. The referencing numerals appearing in FIG. 8 denote the following: 81... cell switch; 82a, 82b, 82c... cell converters; 83... line interface; 84... processor. The details of the configuration and operation of the line interface and of the cell converters will be described with reference to FIG. 9 and FIG. 10.

[0022] FIG. 9 is a block diagram showing the configuration of an embodiment of line interface 83 in FIG. 8. The referencing numerals appearing in FIG. 9 denote the following: 91... PTI checker, 92... cell combiner, 93... controller. A cell that is input to line interface 83 from subscriber line 31 has its header PTI value checked by PTI checker 91. If the cell is a network management cell, it is sent to processor 84 via controller 93. Otherwise, the cell is sent to switch 81. A cell that has been sent to processor 84 has its payload OAM Type (network management cell type identifier) value checked, and the cell is processed. If the network management cell in question is a communication charge notification cell, processor 84 reads the charge information from the payload of the received cell and calculates the

charge for the channel in question. If the network management cell in question is other than a charge notification cell, it is processed by processor 84 and if a reply is required, a reply network management cell is generated and sent to cell combiner 92 via controller 93.

[0023] Processor 84 maintains lists of (i) connections whose routing can be changed, (ii) connections which can be interrupted, and (iii) connections which can be forcibly terminated, during an ongoing session [18]; and lists of (iv) terminals whose current session has been interrupted, and (v) terminals that are not currently communicating but that are able to communicate.

[0024] If the communication charge of an active channel exceeds a predetermined first threshold, processor 84 selects a connection from the list of connections that can be interrupted during a session and the list of connections that can be forcibly terminated during a session, and notifies the cell converter 82 that serves the connection in question that [*the connection*] will be interrupted or terminated.

[0025] If the received active and standby channel communication charges are lower than a predetermined second threshold, processor 84 sends a new connection setup request to the network. If the network approves the setup request, [*processor 84*] selects a terminal from the list of terminals whose session is currently interrupted and from the list of terminals which are able to communicate, and notifies the cell converter that serves the terminal in question of the VPI and VCI assigned by the network.

[0026] Processor 84 compares the active and standby channel communication charges received via charge notification cells, and if the standby channel charge is cheaper and there is a connection registered in the list of connections for which a channel can be changed, it sends a new connection setup request to the network. If the network approves the setup request, [*processor 84*] selects a connection from the list of connections for which a channel can be changed, and notifies the cell converter that serves the connection in question of (i) the routing change, and (ii) the VPI and VCI assigned by the network.

[0027] FIG. 10 is a block diagram showing the configuration of an embodiment of cell converter 82a in FIG. 8. The referencing numerals in FIG. 10 denote the following: 95... controller, 96... receive ATM adaptation layer (AAL) processor – i.e., a circuit for creating a message such as a packet by combining a plurality of cells from which the headers have been removed; 97... cell generator; 98... VPI/VCI table. Cell converter 82a that has been notified

by processor 84 of a session start or restart, stores the VPI and VCI notified by controller 95 in VPI/VCI table 98. Next, it notifies terminal 10 of the session start or restart. If information is transmitted from terminal 10, cell generator 97 stores the sent information in the payload portion of an ATM cell; stores the values stored in VPI/VCI table 98 in the VPI and VCI fields of the cell header; and sends the cell to switch 81.

[0028] In a cell converter that has been notified by processor 84 that [*a session*] will be interrupted or terminated, controller 95 notifies terminal 10 of the interruption or termination. After a reply has come back from terminal 10, [*controller 95*] notifies processor 84 that it has interrupted or terminated [*the session*]. When the processor receives this notification, it sends a connection disconnect request to the network.

[0029] Controller 95 of cell converter 82a that has been notified of a routing change by processor 84 stores the notified VPI and VCI values in VPI/VCI table 98. Receive ATM adaptation layer processing is carried out, and cell generator 97 stores the information sent from terminal 10 in the payload portion of an ATM cell; stores the values stored in VPI/VCI table 98 in the VPI and VCI fields of the cell header; and sends [*the cell*] to switch 81. A cell that has been sent from switch 81 to cell converter 82a undergoes receive ATM adaptation layer processing in receive AAL processor 96 and is sent to terminal 10. In the embodiment illustrated in FIG. 10, line interface 83 performed the processing of communication charge notification cells, but it would also be feasible for the processing of charge notification cells to be carried out by the call processing and network management processor.

[0030] FIG. 11 is a block diagram showing the configuration of another embodiment of line interface 52a in FIG. 3. The referencing numerals appearing in FIG. 11 denote the following: 71 and 74... cell header PTI checkers; 72... header converter; 73... processor; 75... cell combiner; 76... timer; 77... counter. Counter 77 counts up by one each time a cell is output from cell combiner 75. Timer 76 periodically [19] sends a signal to counter 77, and when this signal is sent counter 77 notifies processor 73 of the count at that point in time, and resets the count to zero. When processor 73 receives notification of the count, it takes the count in question as [*indicative of*] the state of utilization of the line, stores it in a network management cell, and sends [*this cell*] to call processing and network management processor 53 via header converter 72 and switch 51.

[0031] When a cell is input to line interface 52a, PTI checker 71 checks the header PTI value. If the cell is a network management cell, it is sent to processor 73, otherwise it is sent to

header converter 72. A cell that has been sent to processor 73 has its payload network management cell type identifier value checked, and [*the cell is*] processed. If the network management cell in question is a communication charge notification cell, it is sent to call processing and network management processor 53 via header converter 72 and switch 51. If the network management cell in question is other than a charge notification cell, it is processed by processor 73. If a reply is required, a reply network management cell is generated and sent to either header converter 72 or cell combiner 75.

[0032] FIG. 12 is a block diagram showing the configuration of a second embodiment of call processing and network management processor 53 in FIG. 3. The referencing numerals appearing in FIG. 12 denote the following: 61... packetizer; 62... processor; 63... cell generator; 64... service management list; 65... charge data table; 66... charge register; 67... cell brancher; 68... charge information adding circuit; 69... cell combiner. Brancher 67 checks the PTI field and the OAM Type field of a received cell and in the case of a communication charge notification cell, sends the cell to charge information adding circuit 68. Otherwise, it sends the received cell to packetizer 61. Charge information adding circuit 68 (i) reads, from charge register 66, the charge information pertaining to a charge notification cell sent from brancher 67, (ii) stores the charge information value in a storage field (Info *i*) designated by the value *i* of the traversed node stage number Link Stage, and (iii) sends the cell to cell combiner 69.

[0033] Packetizer 61 restores received cells to packet format and sends [*the resulting packets*] to processor 62. Processor 62 processes the received call processing and network management packets, generates reply network management packets when a reply is required, and sends these to cell generator 63. If the received information relates to line utilization state, the charge corresponding to this utilization state is read from charge data table 65 and stored in an area of charge register 66 corresponding to the line in question.

[0034] If processor 62 decides, from the line utilization states received from communication interfaces 52 and from network management information received from the nodes, that some of the nodes in question or some of the network is congested, it rewrites the values in charge data table 65. Cell generator 63 converts packets to ATM cell format and sends [*the resulting cells*] to cell combiner 69. Cell combiner 69 sends cells that have been sent from cell generator 63 and from charge information adding circuit 68 to switch 51 on the basis of a prearranged priority. In receiving node 2, in similar manner to the first embodiment (see FIG.

4), processor 62 periodically [20] transmits a charge notification cell to the channels registered in service management list 64.

[0035] In the foregoing embodiment, it was subscriber equipment 6 which controlled communication channels, but it would also be possible for channels to be controlled at node 1, which serves the source subscriber. A third embodiment of the present invention, in which communication channels are controlled at node 1 serving the source subscriber, is described below. [*In this third embodiment*], terminal 10 and subscriber equipment 6 give notification of: (i) connections whose routing can be changed, (ii) connections which can be interrupted, and (iii) connections which can be forcibly terminated, during an ongoing session; and of (iv) terminals whose current session has been interrupted, and (v) terminals which are not currently communicating but which are able to communicate. Node 1 maintains this information in call processing and network management processor 62.

[0036] In FIG. 7, a cell that is input to line interface 52a of node 1 has its header PTI value checked by PTI checker 71. If the cell is a network management cell, it is sent to processor 73; otherwise it is sent to header converter 72. A cell that has been sent to processor 73 has its payload OAM Type (network management cell type identifier) value checked, and the cell is processed. If the network management cell in question is other than a communication charge notification cell, it is processed by processor 73 and if a reply is required, a reply network management cell is generated and sent to header converter 72 or cell combiner 75.

[0037] If the network management cell in question is a communication charge notification cell and if node 1 is not a source node on the channel in question, processor 73 reads charge information from charge register 79, stores it in storage field Info ***i*** designated by the value ***i*** of Link Stage (the traversed node stage number), and sends [*the cell*] to header converter 72. If the network management cell in question is a charge notification cell and node 1 is a source node on the channel in question, processor 73 sends the cell in question to call processing and network management processor 62 via header converter 72 and switch 51. Call processing and network management processor 62 reads the charge information from the payload of the received cell and calculates the communication charge for the channel in question.

[0038] If the communication charge of the active channel exceeds a predetermined first threshold, processor 62 of node 1 selects a connection from the list of connections that can be interrupted during a session and the list of connections that can be forcibly terminated during

a session, and uses a network management cell to notify terminal 16 or subscriber equipment 6 that serves the connection in question that [*the connection*] will be interrupted or terminated.

[0039] If the received active and standby channel communication charges are lower than a predetermined second threshold, processor 62 of node 1 sends a new connection setup request to a channel over which the communication charge is lower than the second threshold. If the setup request is approved, [*processor 62*] selects a terminal from the list of terminals whose session is currently interrupted and the list of terminals which are able to communicate, and uses a network management cell to notify terminal 16 or subscriber equipment 6 that serves the terminal in question, of the assigned VPI and VCI.

[0040] Processor 62 of node 1 compares the active and standby channel communication charges received via charge notification cells, and if the standby channel charge is cheaper and there is a connection registered in the list of connections for which a channel can be changed, it sends a new connection setup request to the standby channel. If the setup request is approved, [*processor 62*] selects a connection from the list of connections for which a channel can be changed, and uses a network management cell to notify line interface 52a that serves the connection in question of (i) the routing information, and (ii) the VPI and VCI assigned to the standby channel. When terminal 16 receives a session start or restart network management cell from processor 62 of node 1, it stores the assigned VPI and VCI values in the header VPI and VCI fields of the ATM cell to be transmitted, sends a reply to processor 62 of node 1, and transmits the cell to node 1.

[0041] If processor 84 of subscriber equipment 6 receives a session start or restart network management cell from processor 62 of node 1, it notifies the cell converter that serves the connection in question of (i) the routing change, and (ii) the VPI and VCI assigned by the network. In the notified cell converter, controller 95 stores the notified VPI and VCI in VPI/VCI table 98, and then notifies terminal 10 of the session start or restart. After receiving a reply [*to the effect that session*] start processing [*has been*] completed at terminal 10 [21], the cell converter sends the reply to processor 62 of node 1. When information is transmitted from terminal 10, cell generator 97 stores the transmitted information in the payload portion of an ATM cell, stores the values stored in VPI/VCI table 98 in the cell header VPI and VCI fields, and sends the cell to switch 81.

[0042] If terminal 16 receives a session interruption or forced termination network management cell from processor 62 of node 1, it performs termination processing and sends a

reply to processor 62 of node 1. If processor 84 of subscriber equipment 6 receives a session interruption or forced termination network management cell from processor 62 of node 1, it notifies the cell converter that serves the connection in question that [*the session*] will be interrupted or terminated. When the cell converter receives notification from processor 84 that [*the session*] will be interrupted or terminated, it notifies terminal 10 via controller 95 of the interruption or termination, and after a reply has been sent back from the terminal, it notifies processor 84 that [*the session*] has been interrupted or terminated. When processor 84 receives this notification, it sends a reply to processor 62 of node 1.

[0043] If processor 73 of line interface 52a receives notification of a routing change from processor 62 of node 1, it (i) stores the notified VPI and VCI in the VPI and VCI storage areas of header converter 72 for the channel in question; (ii) stores the changed routing information in a routing information storage area, and (iii) sends a reply to processor 62. An ATM cell for the routing-changed channel in question that passes through this line interface after these storage operations have been finished (i) has its new VPI and VCI values stored in the header VPI and VCI fields, (ii) has the changed routing information added as an added header, and (iii) is sent to switch 51. The VPI and VCI information in the nodes on the changed channel, and the routing information, is set up when a standby channel is set up, and therefore a routing change can be accomplished by simply changing at node 1.

Effects of the invention

[0044] A subscriber terminal or a network node controls session start, termination, interruption and restart so as to minimise cost, on the basis of notified traffic-related information such as communication charge. Traffic therefore shifts to a line with a lower communication charge – i.e., to a line with less traffic – and traffic is smoothed. In addition, if the communication charge becomes higher, subscribers are urged to terminate or interrupt sessions in order to reduce cost, and can therefore be urged to decrease the traffic input to a line on which there is a large amount of traffic or to an overloaded line.

[0045] In addition, even if a malicious subscriber or a malfunctioning subscriber terminal were to try to add traffic to an overloaded line, the network would reject the channel setup request and therefore no further overloading would occur.

[0046] A subscriber can reduce communication cost by implementing control to smooth the amount of traffic.

Brief Description of the Drawings

FIG. 1 illustrates an embodiment of a communication network in which the routing method of the present invention is implemented.

FIG. 2 is a graph showing an example of the relation between communication charge and traffic that is set up in a charge table in an embodiment of the invention.

FIG. 3 is a block diagram of the configuration of an embodiment of node 2 in FIG. 1.

FIG. 4 is a block diagram of the configuration of an embodiment of processor 53 in FIG. 3.

FIG. 5 illustrates an embodiment of service management list 64 in FIG. 4.

FIG. 6 shows the format of a network management cell used for network management.

FIG. 7 is a block diagram of the configuration of an embodiment of line interface 52a in FIG. 3.

FIG. 8 is a block diagram of the configuration of an embodiment of subscriber equipment 6 in FIG. 1.

FIG. 9 is a block diagram of the configuration of an embodiment of line interface 83 in FIG. 8.

FIG. 10 is a block diagram of the configuration of an embodiment of cell converter 82a in FIG. 8.

FIG. 11 is a block diagram of the configuration of another embodiment of line interface 52a in FIG. 3.

FIG. 12 is a block diagram of the configuration of a second embodiment of call processing and network management processor 53 in FIG. 3.

Explanation of referencing numerals

1–5 .... nodes
6, 7 .... subscriber equipment
10–16 .... terminals
21–25 .... internode lines
31–39 .... subscriber lines
40–45 .... in-home lines
51 .... ATM cell switch
52a–52e .... line interfaces for interfacing with communication lines
53 .... call processing and network management processor
61 .... packetizer
62 .... processor
63 .... cell generator
64 .... service management list
71, 74 .... cell header PTI checkers

72.................. header converter

73.................. processor

75.................. cell combiner

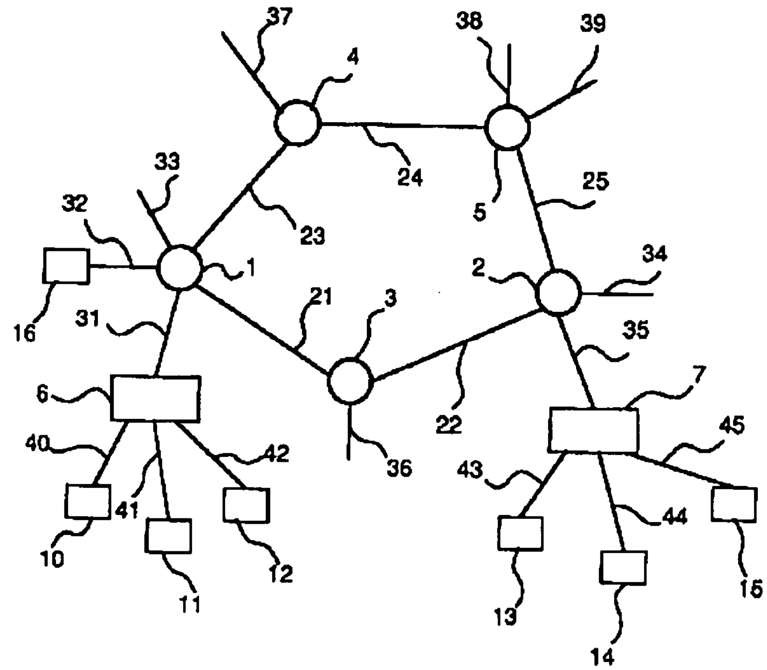
76.................. timer

77.................. counter

78.................. charge table

79.................. charge register

FIG. 1



1-5: nodes; 10-16: terminals; 21-25: internode lines;
31-39: subscriber lines; 40-45: in-home lines

FIG. 2

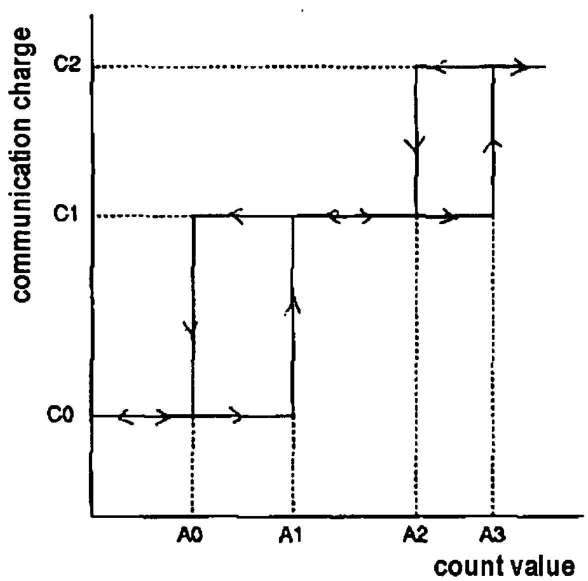
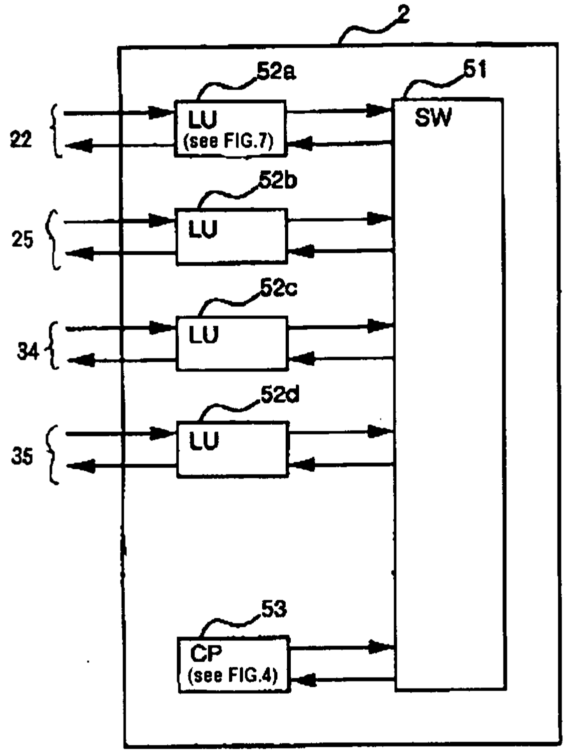


FIG. 3



2: node; 51: switch; 52a-52d: line interfaces; 53: processor

FIG. 4

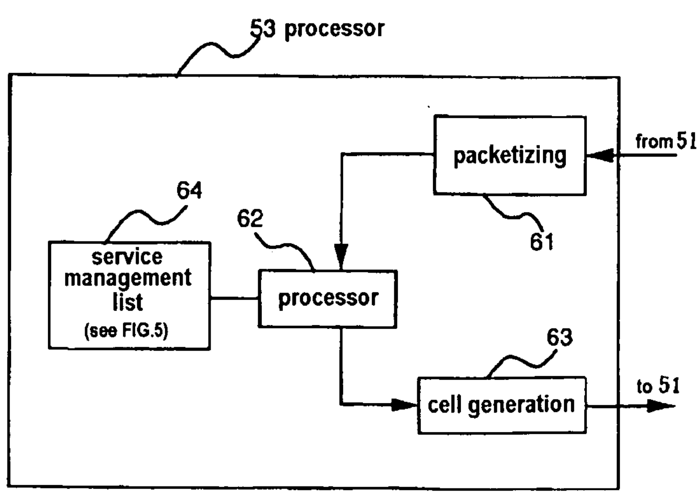


FIG. 5

64 service management list

VPI1	VCI1
VPI2	VCI2
⋮	⋮
VPI m	VCI m
VPI m+1	VCI 0
VPI m+2	VCI 0
⋮	⋮
VPI m+k	VCI 0

FIG. 6

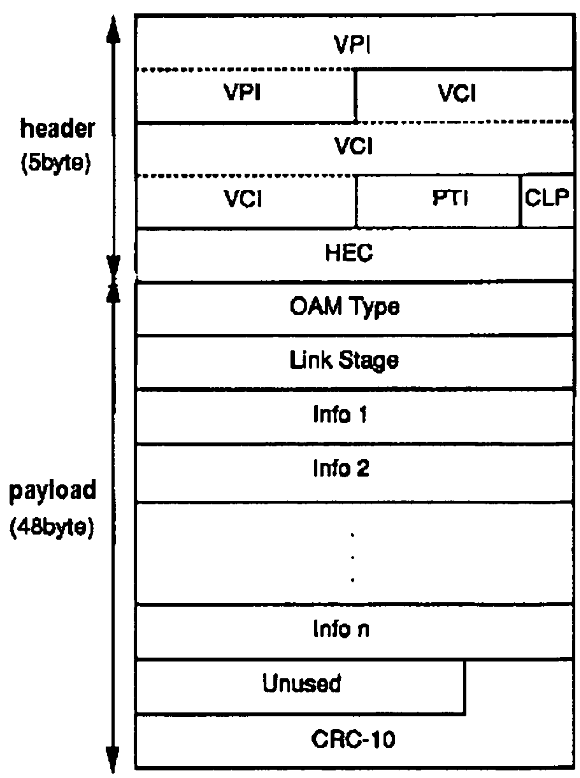


FIG. 7

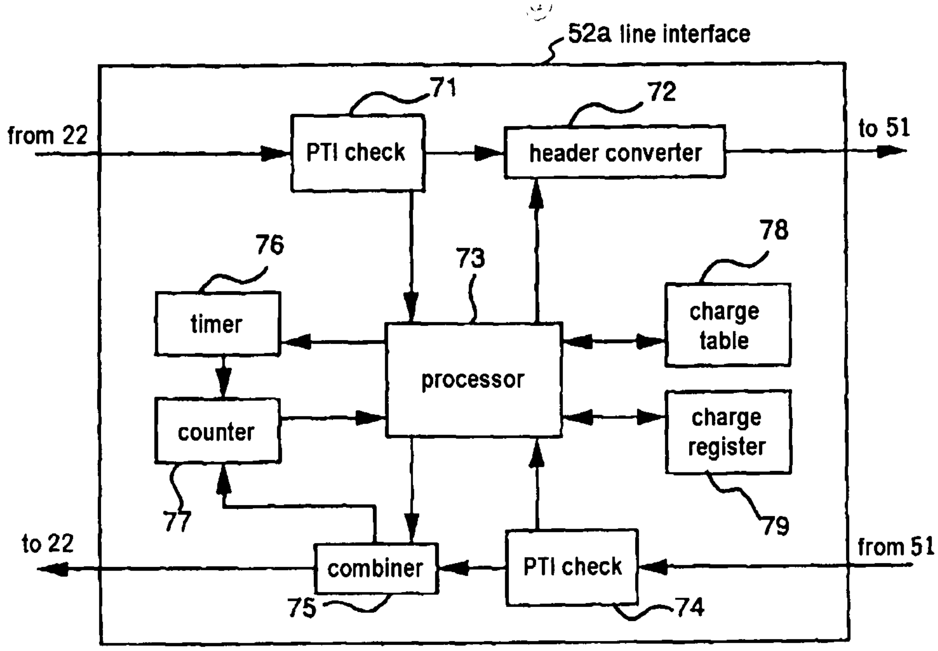
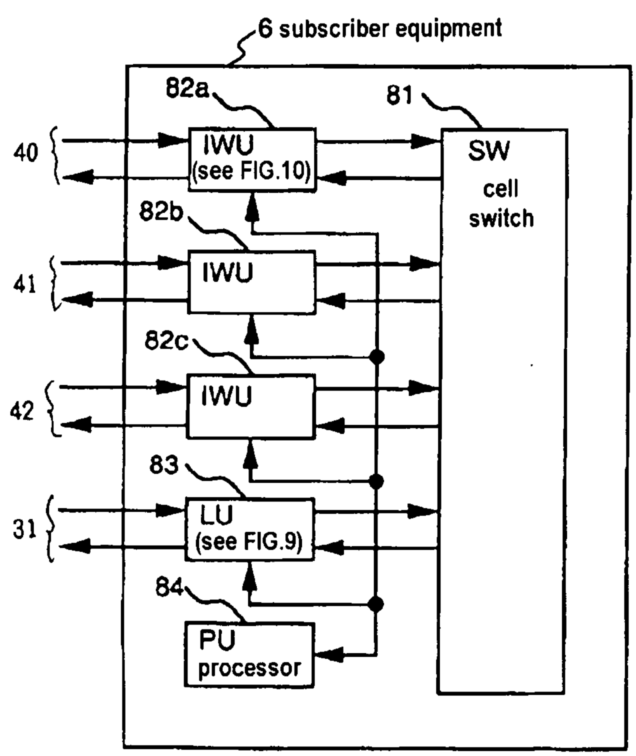


FIG. 8



82a-82c: cell converters, 83: line interface, 84: processor

FIG. 9

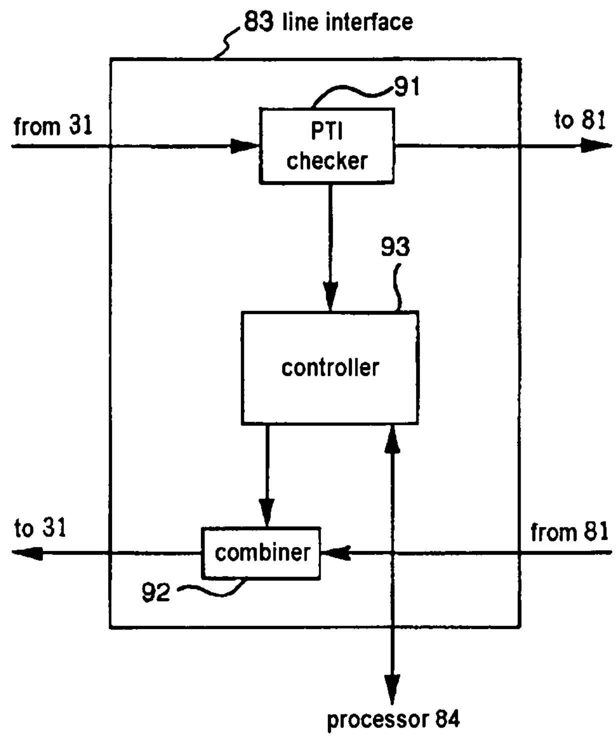

83 line interface
91
from 31
PTI checker
to 81
93
controller
to 31
combiner
from 81
92
processor 84

FIG. 10

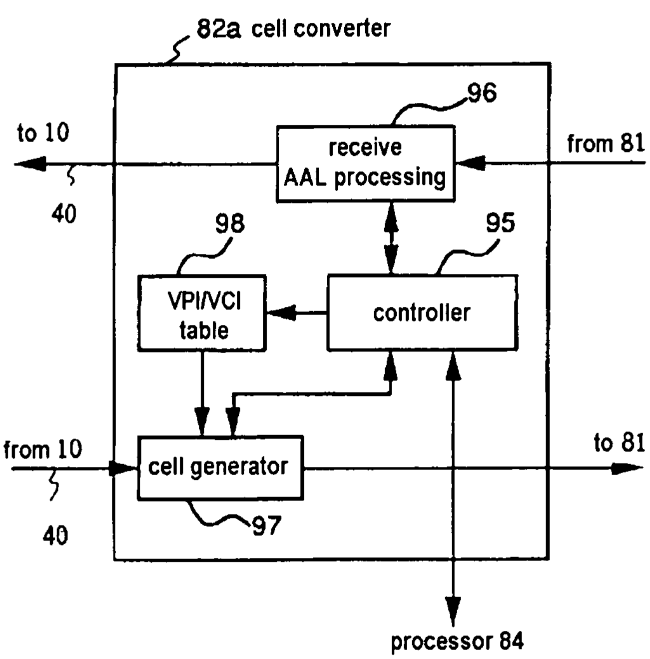

82a cell converter
96
to 10
receive AAL processing
from 81
40
98
95
VPI/VCI table
controller
from 10
cell generator
to 81
40
97
processor 84

FIG. 11

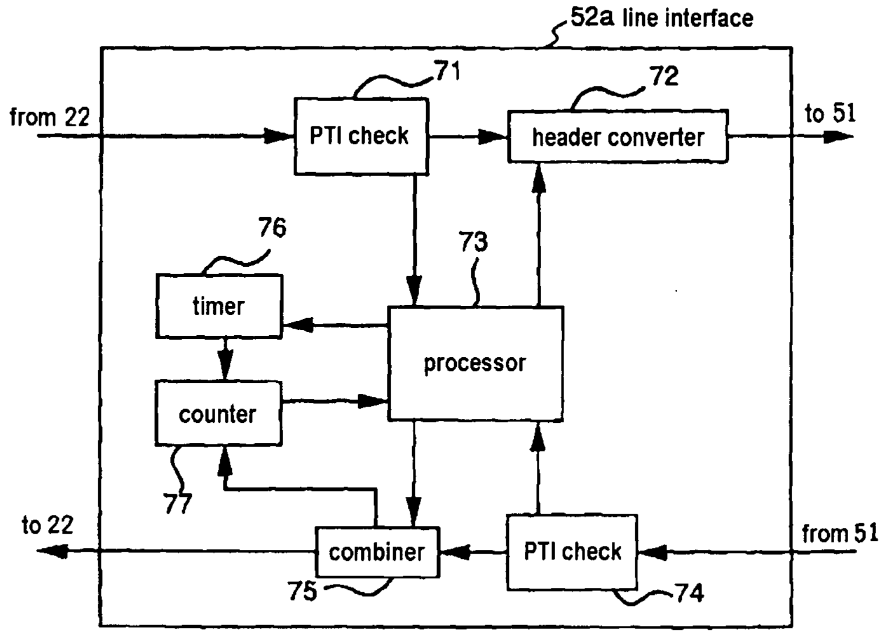
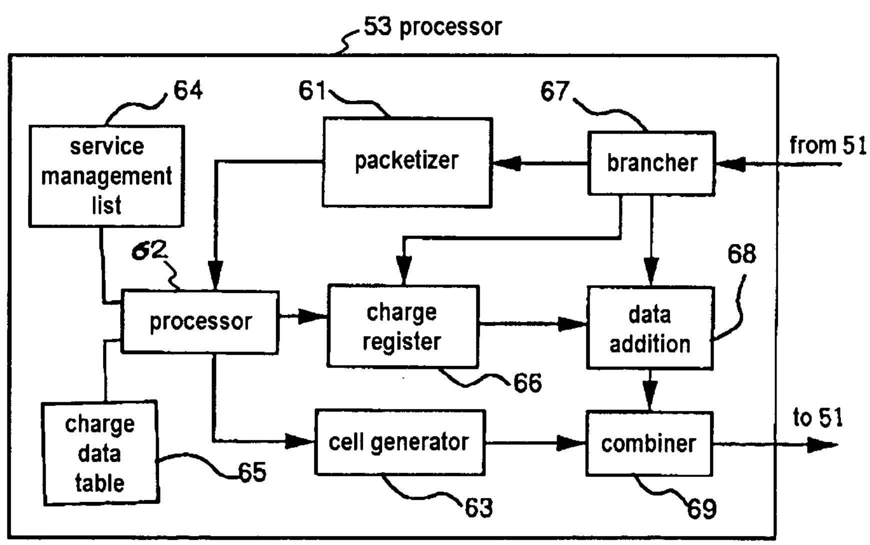

52a line interface
71
72
from 22
PTI check
header converter
to 51
76
73
timer
processor
counter
77
to 22
combiner
PTI check
from 51
75
74

FIG. 12


53 processor
64
61
67
service management list
packetizer
brancher
from 51
62
68
processor
charge register
data addition
66
charge data table
65
cell generator
combiner
to 51
63
69

TRANSLATOR'S NOTES

1. Hereinafter, in many cases I will translate the Japanese for "communication charge" simply as "charge".

2. I have added the italicised words in square brackets to clarify the meaning of the Japanese, which omits any corresponding words. This same remark applies to other instances of italicised words in square brackets.

3. Again, to avoid cumbersome repetition, in many cases I will translate the Japanese for "communication channel" simply as "channel".

4. Hereinafter, in many cases I will translate the Japanese for "communication line" simply as "line".

5. Hereinafter, I translate the Japanese for "subscriber communication equipment" simply as "subscriber equipment".

6. To avoid unnecessary repetition, I will sometimes translate the Japanese for "communication network" simply as "network".

7. Hereinafter, I will translate the Japanese for "communication terminals" simply as "terminals".

8. Hereinafter, I will translate the Japanese for "communication nodes" simply as "nodes".

9. Here and throughout the translation, "source terminal" is a free translation of the corresponding Japanese phrase, which is literally, "communication terminal which is to transmit".

10. Again, here and throughout the translation, "destination terminal" is how I render the corresponding Japanese, which is literally, "receive terminal".

11. Hereinafter, I will translate the Japanese for "ATM switched network" simply as "ATM network".

12. The term "active connection" is my translation of a Japanese term which is literally, "connection during communication".

13. Sic.

14. In this case, the Japanese is literally, "at a constant period".

15. I presume that by "storage fields", the writer is referring to the Info fields for storing charge information.

16. This sentence seems strange: how can a virtual path connection and a virtual channel connection have a single VPI and a single VCI, as the sentence seems to suggest?

17. See Note 14.

18. The Japanese that I have translated as "during an ongoing session" is literally, "during a current communication".

19. See Note 14.

20. See Note 14.

21. This is my free translation of the Japanese, which is literally, "After receiving a terminal 10 start processing finish reply...".